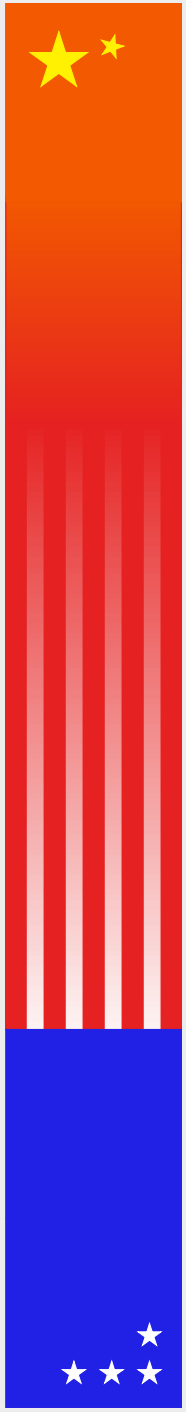
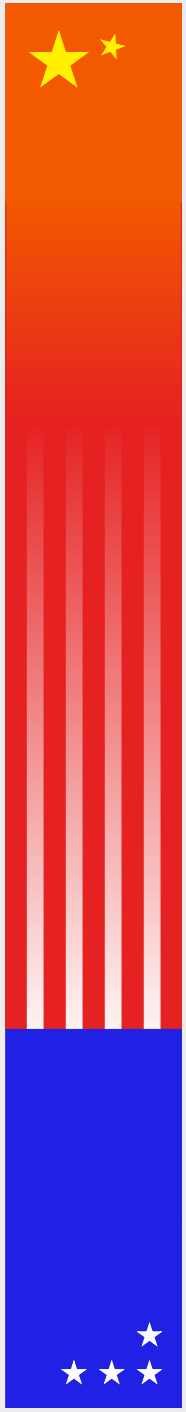


# The Mathematics Curriculum at the Princeton International School of Mathematics and Science: Creativity and Innovation

Dr. Vince Matsko
Mr. Joseph Li

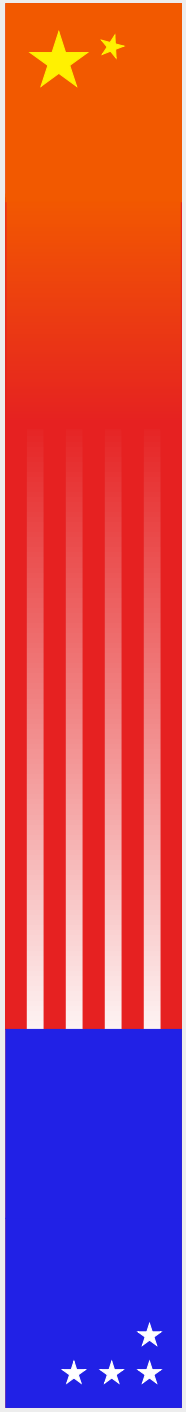
The 4th National Principals' Training Symposium: Educating Talented Students
Beijing
23 March 2014



# Presentation Overview

- Principles and Standards
- Specific Examples: PQDA-Days (Li) and Original Problems (Matsko)
- Dodecahedron Day Activity
- Summary

Click on beijing 2014.



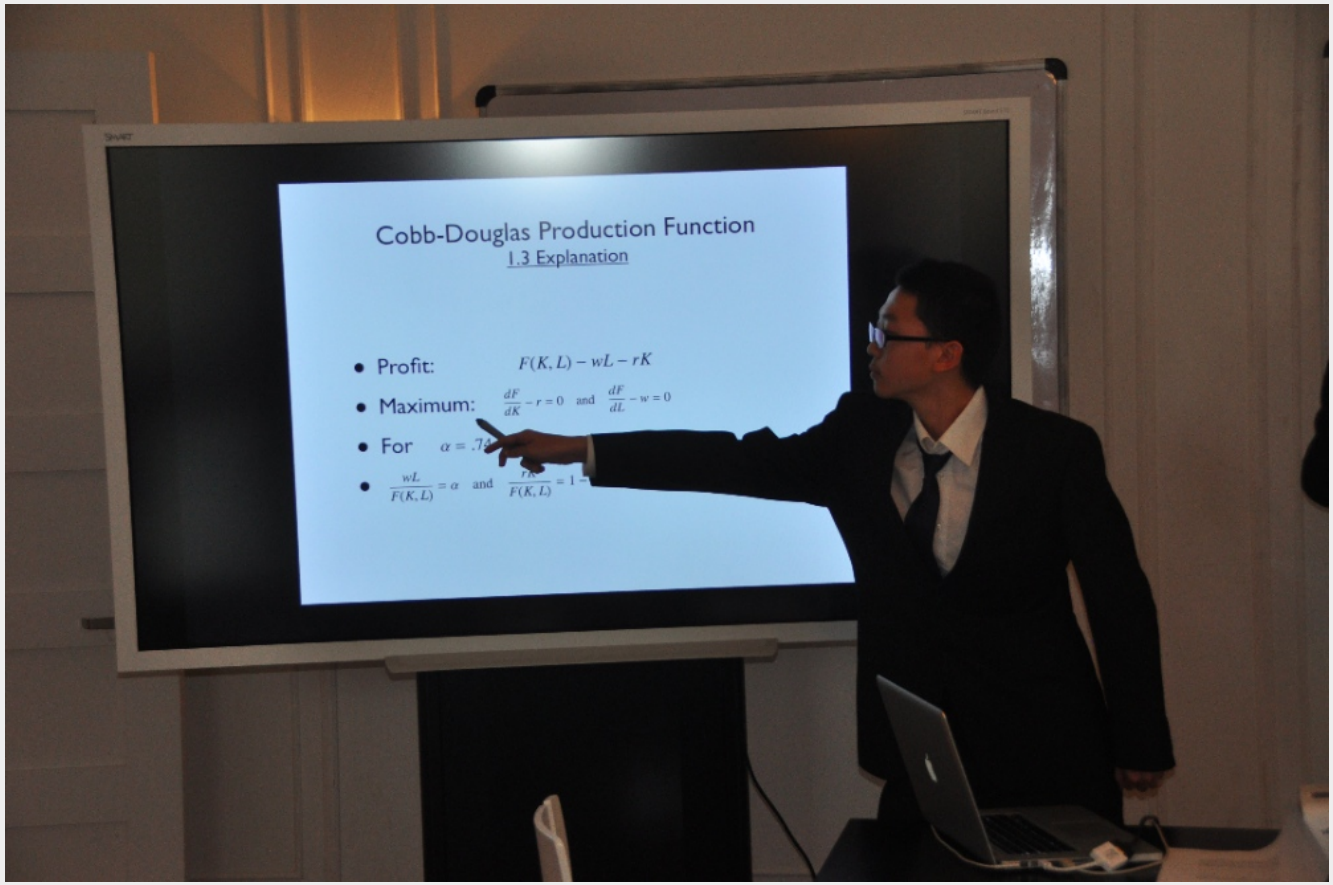
# Mission Statement

PRISMS graduates will have an authentic experience of mathematics as a scientific discipline.

# Presentation Day (Inspire inquiry!)


Presentation on Economics

# Presentation Day




Presentation on Economics

## Guiding Principles

Three principles guide us in carrying out our mission:

(P1) Students will be actively engaged in learning mathematics.

(P2) Students will become independent learners of mathematics.

(P3) Not all students learn in the same way.

## Distinguishing Mathematics at PRISMS

(D1) Students write and solve their own Original Problems.

(D2) In some courses, the week is organized according to a schedule of P-days (presentation), D-days (discussion), Q-days (quiz or test), and A-days (question and answer).

(D3) In some classes, students work largely at their own pace.

(D4) Students give formal Final Presentations rather than take Final Exams.

(D5) Different teachers use different teaching styles.

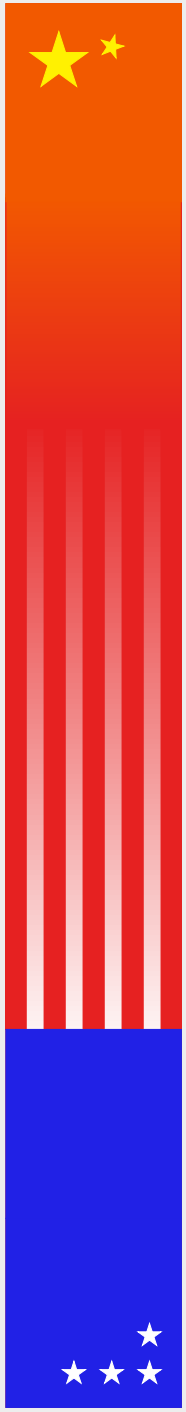
(D6) Students use technology to think differently about mathematics problems.

## Standards Overview

1. Metastandards: These standards apply to all disciplines at PRISMS. The Metastandrads reflect the underlying philosophy of teaching and learning at PRISMS.

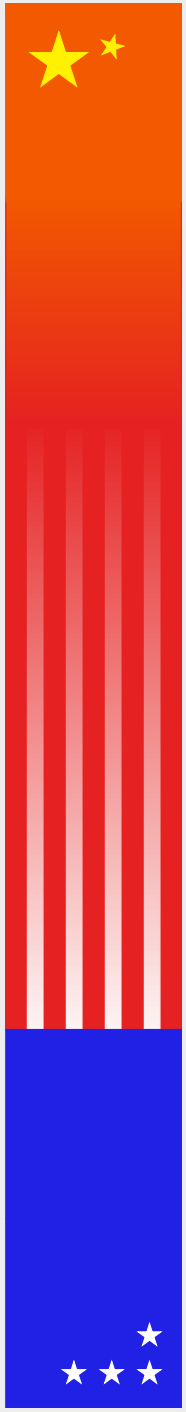
2. Interdisciplinary Standards: These standards cross disciplines. The Interdisciplinary Standards reflect the relatedness of various disciplines.

3. Intradisciplinary Standards: These standards are discipline-specific. The Intradisciplinary Standards allow focus on a particular discipline, and reflect each discipline's unique contribution to learning at PRISMS.



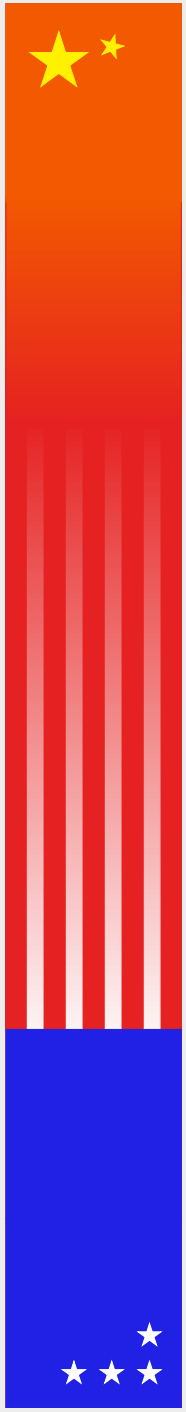
## Note

Standards highlighted in orange will apply to the discussion of PQDA Days, while standards highlighted in blue will apply to the discussion of Original Problems. Those that apply to both will be indicated by "[Both]."



## Statement of Collaboration

These Principles and Standards reflect many conversations between the Chinese mathematics teacher, Joseph Li, and the American mathematics teacher, Vince Matsko. We worked hard to incorporate the best ideas from our different teaching experiences, both in China and the United States. We hope to create a new environment for teaching and learning which may be a model for other schools around the world. (Nurturing community.)



# I. Metastandards

Students educated at PRISMS will:

1. cultivate a positive attitude toward learning and a passion for inquiry; [Both]
2. embrace learning and working in academic disciplines as a creative and purposeful endeavor; [Both]
3. understand the cultural and historical context of each academic discipline;
4. appreciate the aesthetics of the academic disciplines;
5. apply critical reading and reasoning skills to designing, analyzing, synthesizing, and evaluating their studies within and among all academic disciplines; [Both]
6. communicate their ideas about academic disciplines through group discussion, oral presentation, and written expression; [Both]

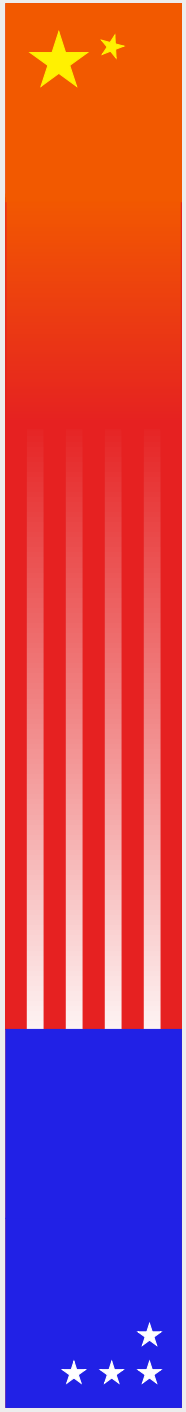
## I. Metastandards (continued)

Students educated at PRISMS will:

7. situate and construct connections among academic disciplines;
8. demonstrate persistence and resilience;
9. attain global competence through collaborative endeavors, social enterprises, and work in cross-cultural teams;
10. use advanced and emerging technologies as a means of enhancing and extending their study of the academic disciplines;
11. uphold the highest standards of academic integrity and professional ethics in both the classroom and the community.

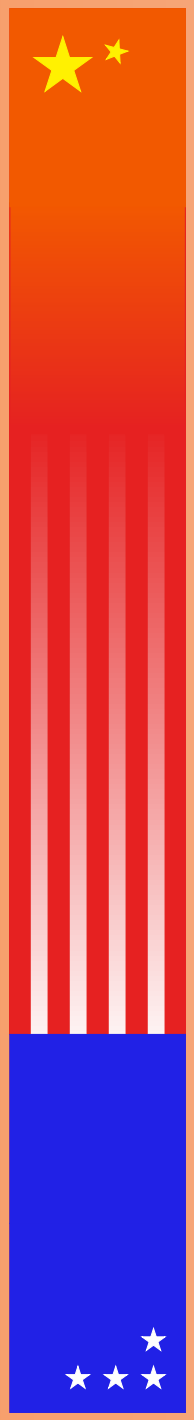
## II. Interdisciplinary Standards

12. Students will solve routine problems using known techniques.
13. Students will solve non-routine problems by extending the use of known techniques or developing new techniques.
14. Students will create mathematical models in order to solve real-world problems.
15. Students will create original, well-posed problems, assess their difficulty, and solve them to the extent possible with existing knowledge.

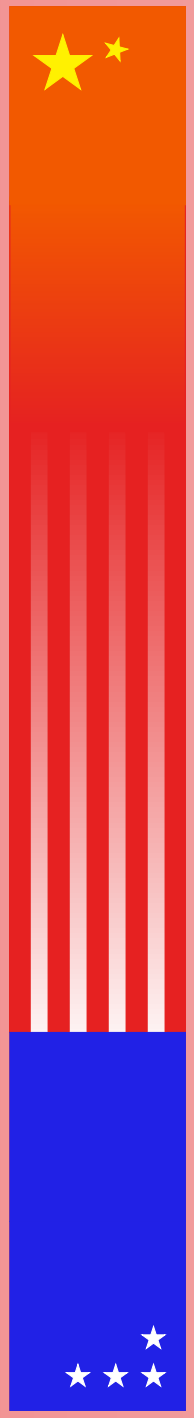


## III. Intradisciplinary Standards

16. Students will reason mathematically. [Both]
17. Students will construct sound proofs.
18. Students will critique the validity of mathematical arguments.



# New Journey in New Jersey



# Original Problems

## What is an Original Problem?

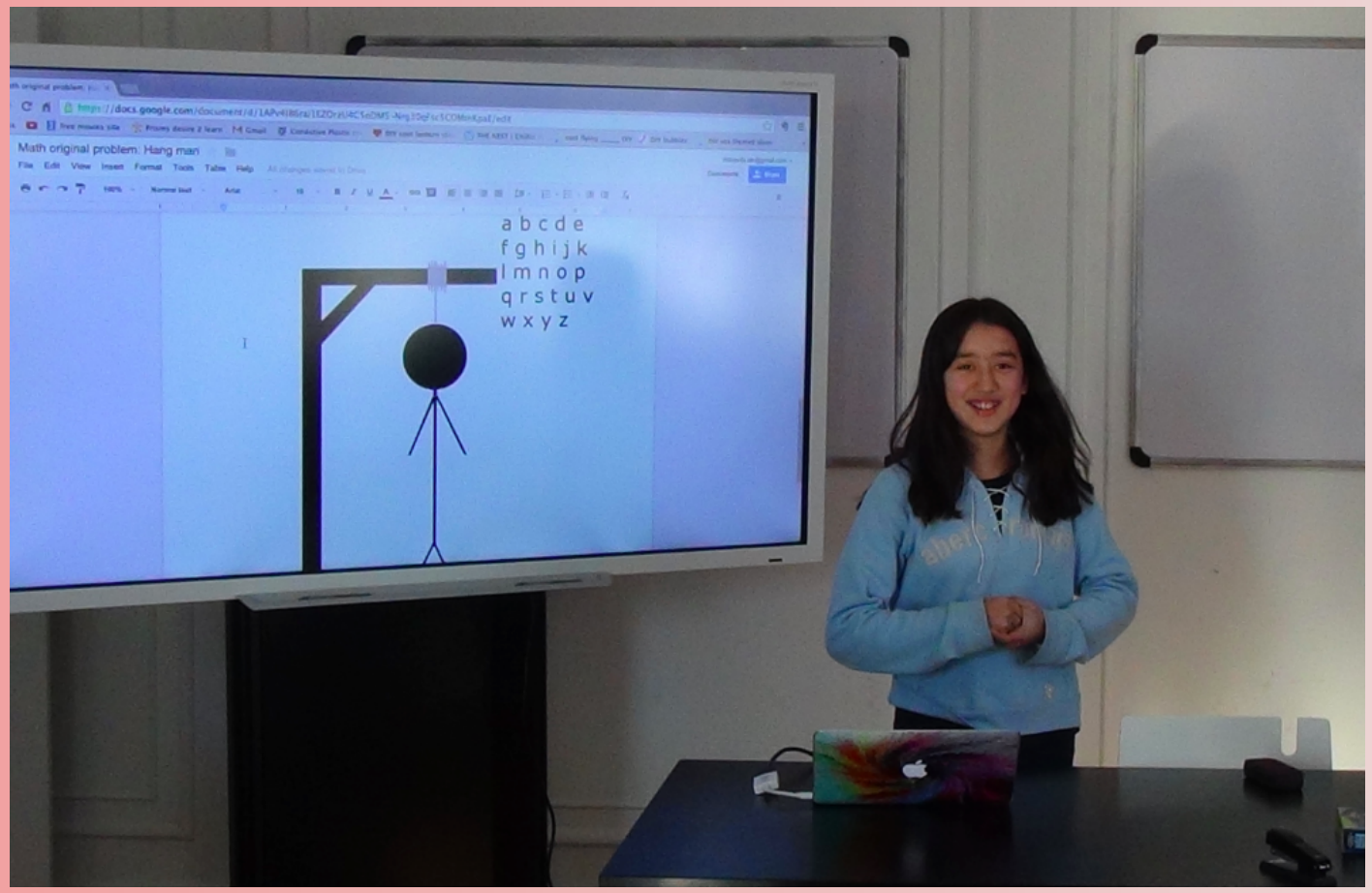
This assignment is a short essay including the following components:

- Motivation: Why did you choose this problem?
- Problem Statement: This should be clearly stated.
- Problem Solution: Solve the problem as completely as possible.
- Reflection: What did you learn?

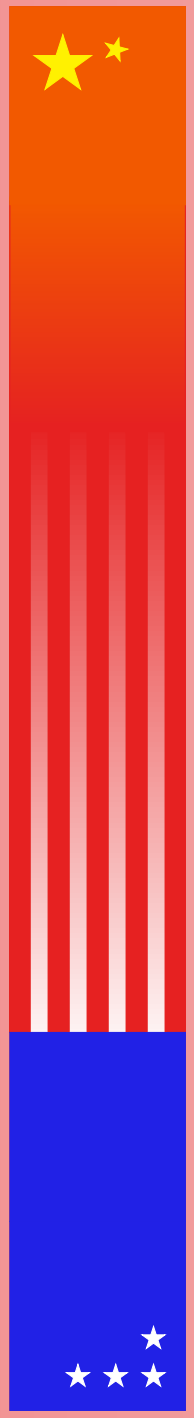
## Brief History

- Began using Original Problems in 2008 in Advanced Problem Solving (IMSA).
- Started with advanced students, then moved on to beginning students.
- With colleague Dr. Gerald (Jay) Thomas (Aurora University), published two research papers.
- Spoke at conferences in the USA, Latvia, Thailand, Korea, and (now!) China.

# Original Problems

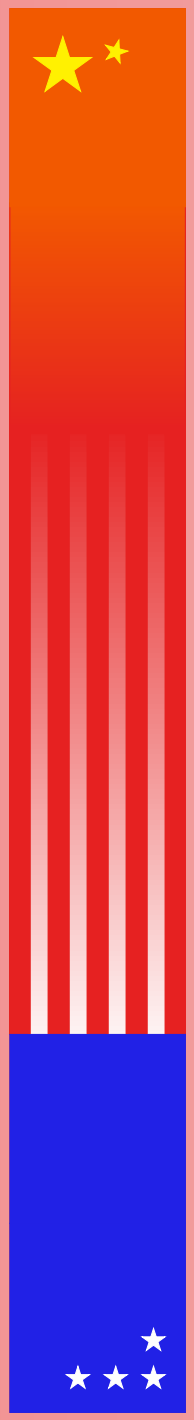



Original Problem discussion



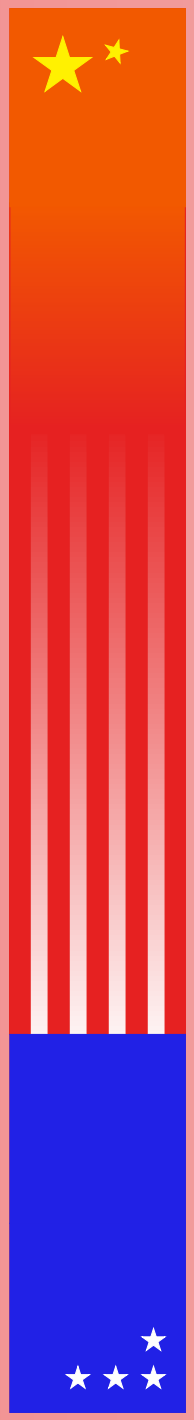
# Problem Design

We will see two short videos of students presenting their Original Problem statements.



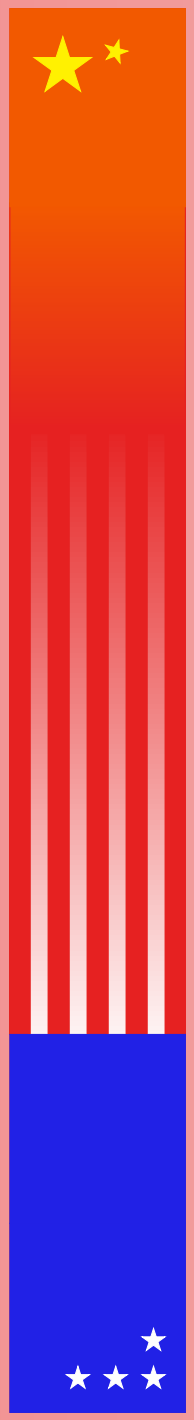
## On Creativity (EL, IMSA)

Anyone can write tedious, difficult problems that review core math subjects, but to write problems in a novel, challenging, and refreshing manner, one must be imaginative. I feel that this creative side of math is an often overlooked aspect of the field as many believe math to be an extremely black-and-white, rigid, and boring subject.



## On Problem Writing (PC, IMSA)

Writing original problems has been one of the hardest things that I've ever had to do academically.



# Motivation (RR, PRISMS)

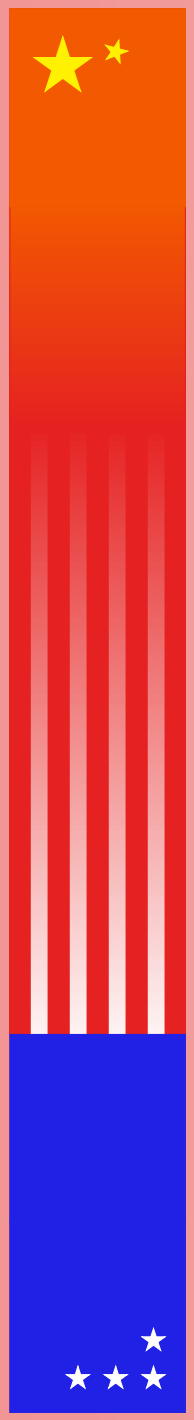
A few months ago, I learnt about vectors in my Physics class. A few weeks ago, I learnt about imaginary numbers from my math textbook. Soon after that, my math teacher taught me how to graph complex numbers. This graphing method fascinated me. I did a little research and came to know how to graph complex numbers properly. For my original problem, I decided to combine my knowledge of vectors and imaginary numbers.

## Problem Statement (AB, PRISMS)

The goal for myself in this problem is to determine the amount of snowfall that comes down on all of campus in kg as well as to try and determine which trees are most susceptible to falling in heavy snow and why.

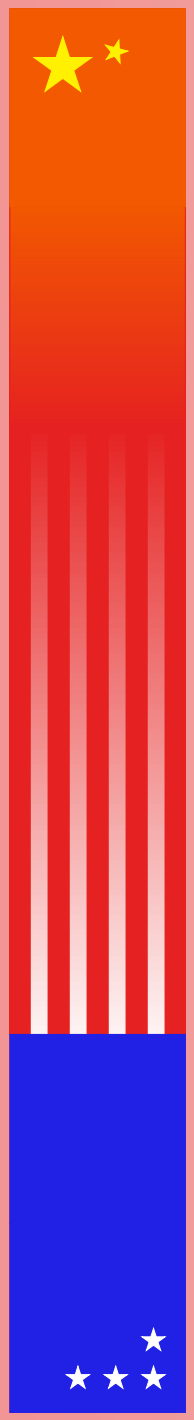
## Problem Statement (AZ, PRISMS)

My problem comes from a story of my mother. When my mother was a child, my grandmother gave her and her sisters a piece of chocolate. My grandmother decided to cut the chocolate randomly for her children according to their age, where the older children would get more chocolate than the younger children. Since my mother is the youngest, how much chocolate could she expect to get?



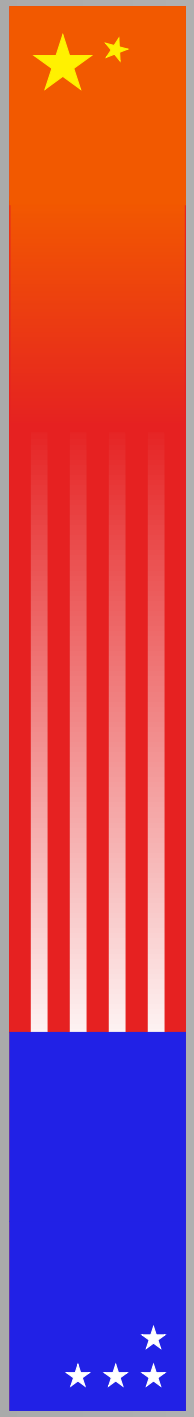
# Problem Solution (AZ, PRISMS)

$$
\begin{aligned}
E_2 &= \iint_{D_2} s_2 \, dA \\
&= \iint_{D_2} \frac{a}{2}(x+y) \, dA \\
&= \int_0^a dx \int_0^{a-x} \frac{a}{2}(x+y) \, dy \\
&= \int_0^a \left( -\frac{a}{4}x^2 + \frac{a^3}{4} \right) \, dx \\
&= \frac{a^4}{6}.
\end{aligned}
$$

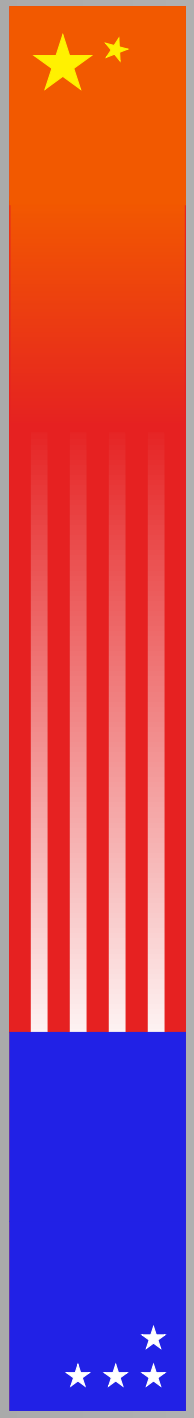


## Reflection (AM, PRISMS)

All in all, I think that the original problem was an interesting one. I am delighted to have at least partially found a solution.

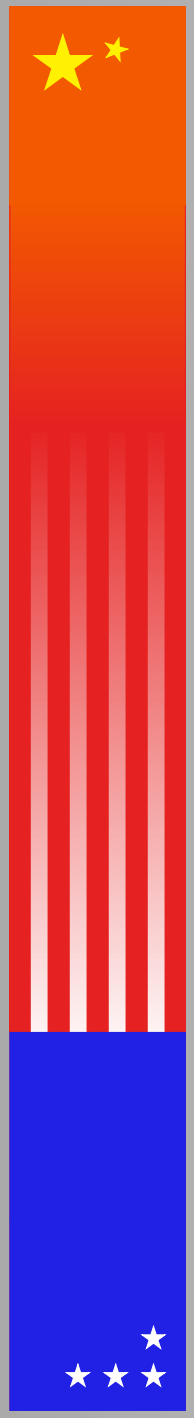


# Dodecahedron Day



## Mission Statement

The purpose of Dodecahedron Day is to engage students of all ages in hands-on geometrical activites intended to foster a joy of investigating mathematical ideas and a desire to learn more mathematics.

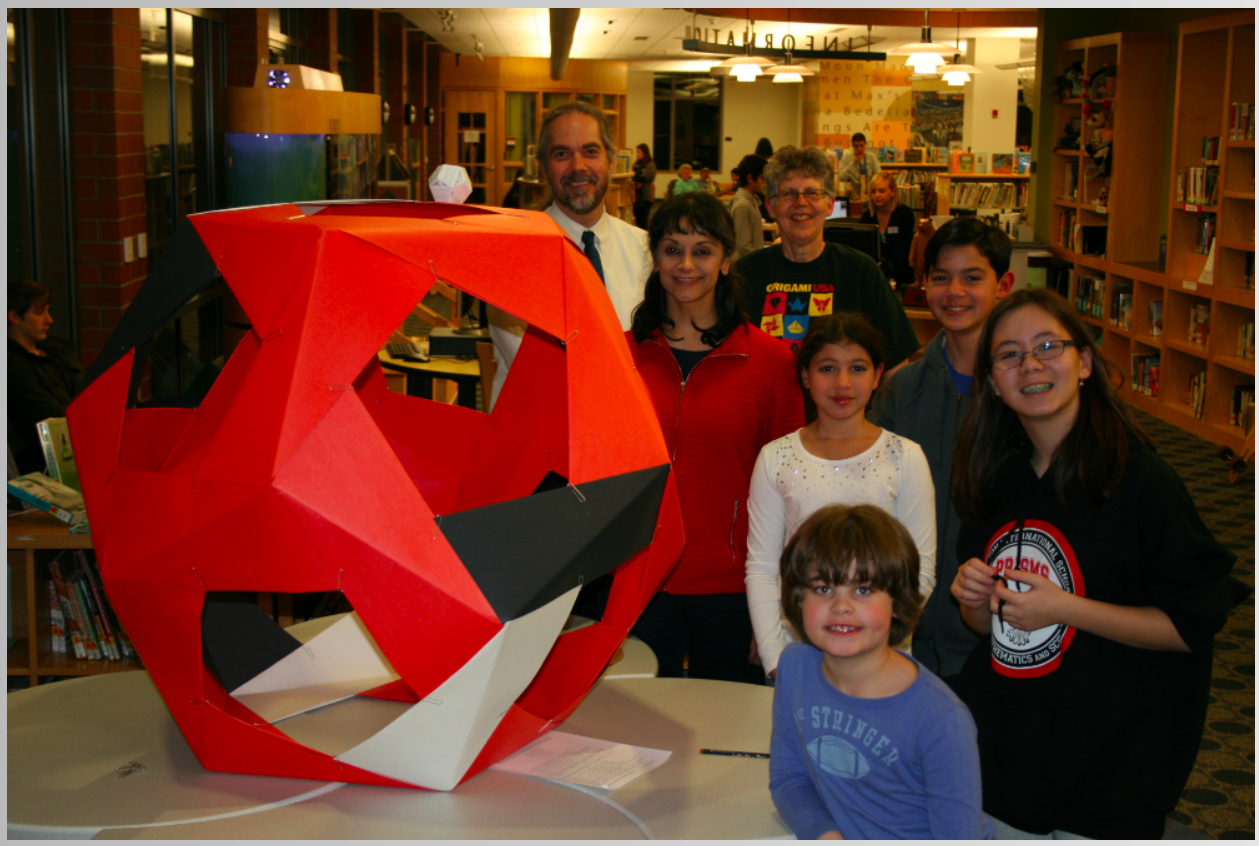


## Mission Statement

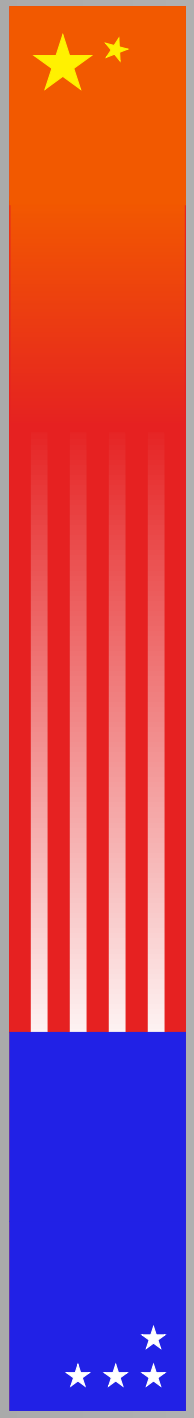
The purpose of Dodecahedron Day is to engage students of all ages in hands-on geometrical activites intended to foster a joy of investigating mathematical ideas and a desire to learn more mathematics.

We will watch a short video documentary about Dodecahedron Day.

# Dodecahedron Day at PRISMS



PRISMS at the Princeton Public Library
December 5, 2013



## Dodecahedron Day at PRISMS

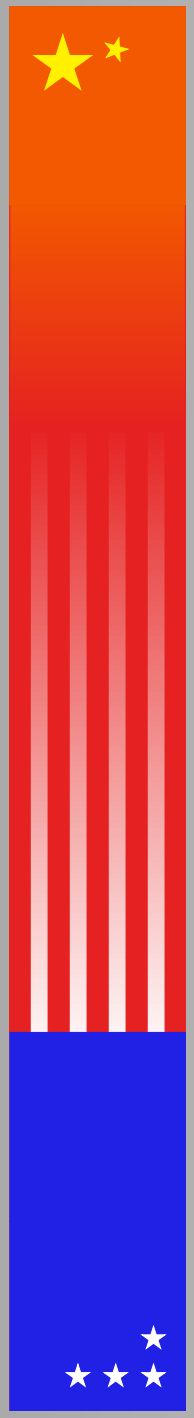
Early morning: Chinese students assist in three classrooms at the Community Park School.

Late morning: American students assist in three classrooms at the Chapin School.

Late afternoon: American students assist almost 100 students at the Princeton Public Library.

# Dodecahedron Day at PRISMS


PRISMS at Community Park School
December 5, 2013

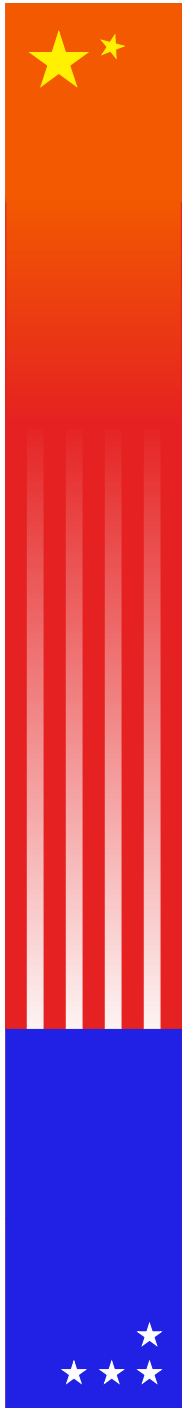


# Dodecahedron Day Activity

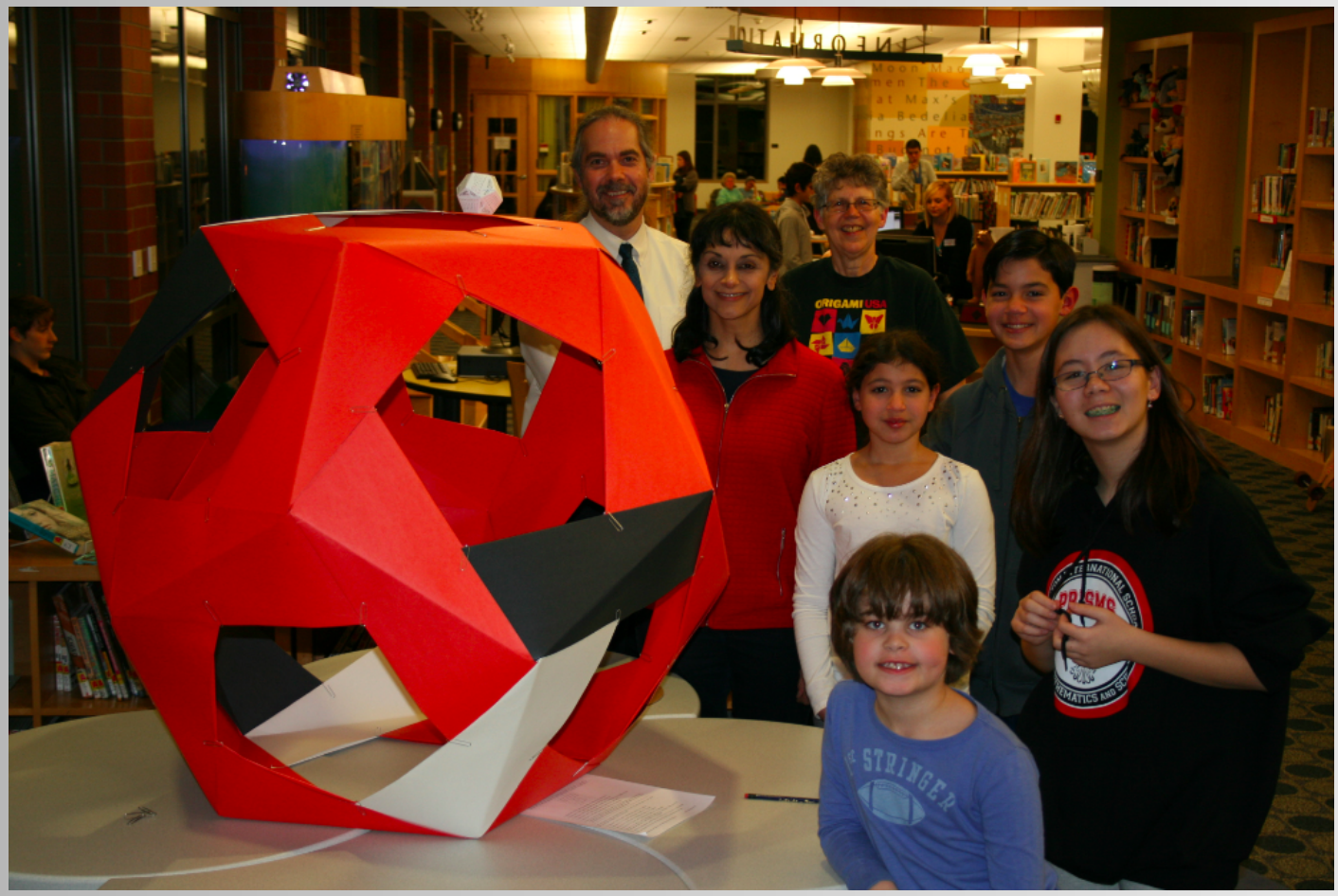
We will now proceed to conduct an activity on stage. This activity was carried out at all locations on Dodecahedron Day 2013.

This activity and many others may be found on the Dodecahedron Day website:

www.dodecahedronday.org.

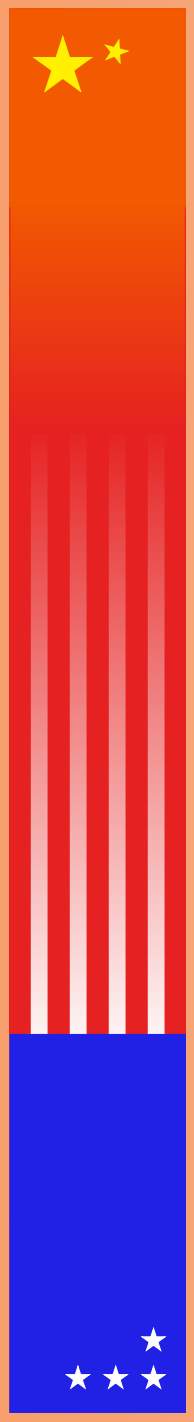


Dodecahedron Day website.


ORIGAMI USA
STRINGER

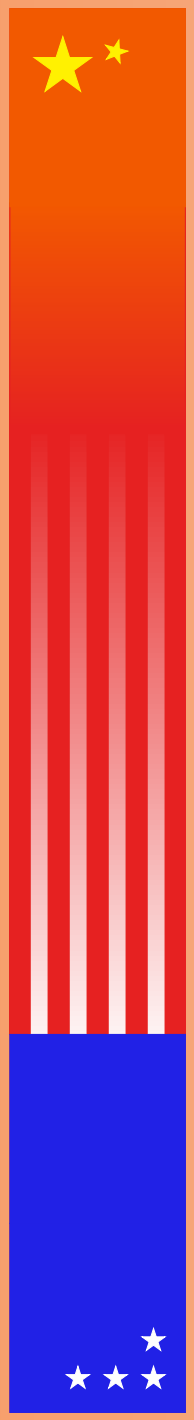
## Student Comments (unedited), I

Math at PRISMS is a very enjoyable class. I can work at my own pace and do not have to wait for anybody else. So if I can fly through Algebra 1 in three months, then I can. Although this requires concentration, self-discipline, and motivation, which is not always the easiest thing to come up with. Another good thing is the ability to choose when your tests are. But once again you have to have responsibility.



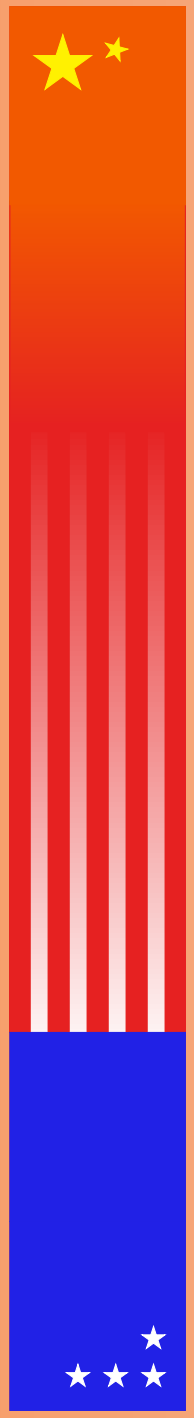
## Student Comments, II

One of my first suggestions, and maybe even the primary one, to get the learning experience at PRISMS really great is for the teacher not to let his students roam around, randomly doing problems. I believe that the mathematics teacher should give lectures: explain the lesson before letting the students do their work.



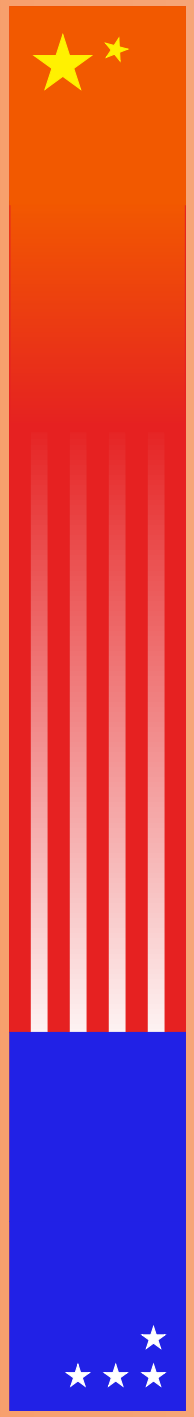
## Student Comments, III

To begin with, I have never imagined students can learn calculus, which is the college-level course, in the high school period. In China, students cannot have the chance to touch the higher-level courses beyond high school level courses in class....However, in PRISMS, we can learn whatever we like. Students of each level can take the course which fits them.



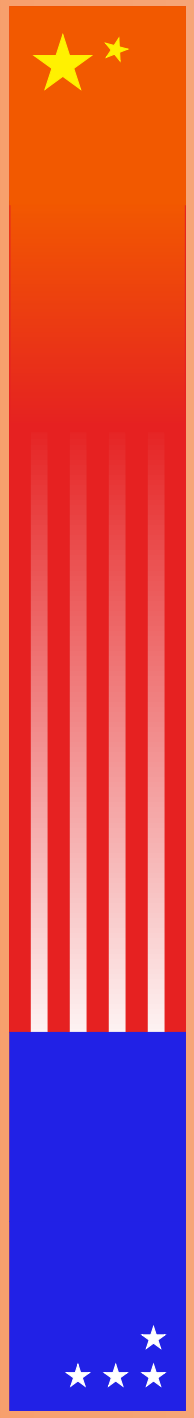
## Student Comments, IV

Prisms Math class really surprises and amazes me very much, because of not only what I have learn in the class, but also the study style and method....In the math class, students are divided into groups according to their levels. In this way, every student can learn as much as they want, and this method has avoided the problem in the larger class where students who are on a higher level cannot learn more.



## Teacher Comment

We are so pleased our students are enjoying mathematics at PRISMS. We cultivate a relaxed, yet rigorous environment where we may illuminate powerful mathematical ideas. Our students have grown tremendously in a very short time. We have only just begun, and we can't wait to see what they can accomplish!



## Teacher Comment

We are so pleased our students are enjoying mathematics at PRISMS. We cultivate a relaxed, yet rigorous environment where we may illuminate powerful mathematical ideas. Our students have grown tremendously in a very short time. We have only just begun, and we can't wait to see what they can accomplish!

Thank you for your attention.